

MS APEAL BRIEF
PATENT
9031-1017

IN THE U.S. PATENT AND TRADEMARK OFFICE BEFORE
THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of
Warren SMOOK et al.
Application No. 10/563,461
Filed January 5, 2006

Appeal No.
Conf. 1343
Group 3655
Examiner Tisha D Lewis

GEAR TRANSMISSION UNIT WITH PLANET CARRIER

APPEAL BRIEF

MAY IT PLEASE YOUR HONORS:

(i) Real Party in Interest

The real party in interest in this appeal is the assignee, HANSEN TRANSMISSIONS INTERNATIONAL, NAAMLOZE VENNOOTSCHAP.

(ii) Related Appeals and Interferences

None.

(iii) Status of Claims

Claims 1-13, 15 and 16 are pending in this application from whose final rejection this appeal is taken. Claim 14 was canceled.

(iv) Status of Amendments

There are no outstanding amendments. The claims have not been amended since the June 3, 2010 amendment. These claims were finally rejected by the Official Action mailed August 18, 2010. The claims are as set forth in the Claims Appendix.

(v) Summary of Claimed Subject Matter

The claimed subject matter relates to a planetary gear transmission unit.

More specifically, independent claim 1 is directed to a transmission unit (11) comprising sun (27), planet (25) and ring gears (24) and a planet carrier (28), the planet carrier having circumferentially spaced studs (42) which support a planet bogie plate (43), the planet bogie plate providing support for circumferentially spaced shafts (44), which support and locate circumferentially spaced planet gear bearings on which planet gears (47, 48) are mounted, and at least some of the planet gear bearings being taper roller bearings (45, 46). (See, page 4, line 1 to page 5, line 12; Figures 2-4).

Claim 13 depends from claim 1 and defines that the planet gears (47, 48) are supported relative to the bogie plate by a flexpin shaft. (See, page 5, lines 13-23; Figures 5-6).

(vi) Grounds of Rejection to be Reviewed on Appeal

A first ground of rejection on appeal is whether claims 1-12, 15 and 16 were properly rejected under 35 U.S.C. § 103(a) as being unpatentable over WO 02/079644 (WO '644) in view of WO 0157398 (WO '398).

A second ground of rejection on appeal is whether claims 1-13, 15 and 16 were properly rejected under 35 U.S.C. § 103(a) as being unpatentable over WO 02/14690 (WO '690) in view of WO '398.

A third ground of rejection on appeal is whether claims 1-13, 15 and 16 were properly rejected under 35 U.S.C. § 103(a) as being unpatentable over WO 03/014566 (WO '566) in view of WO '398.

A fourth ground of rejection on appeal is whether claim 13 was properly rejected under 35 U.S.C. § 103(a) as being unpatentable over WO '644 in view of WO '398, and further in view of WO '690 and WO '566.

(vii) Arguments

(vii-a) Summary of the Arguments

The present invention is directed to a planetary gear transmission unit as is seen in Figures 2-4 below. As can be seen, the transmission unit includes sun, planet and ring gears and a planet carrier. The planet carrier has circumferentially spaced

studs which support a planet bogie plate, the planet bogie plate providing support for circumferentially spaced shafts, which support and locate circumferentially spaced planet gear bearings on which planet gears are mounted, and at least some of the planet gear bearings are taper roller bearings. (See, claim 1).

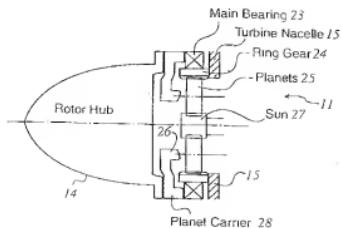


FIG. 2

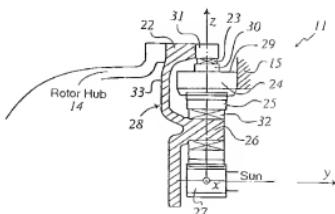


FIG. 3

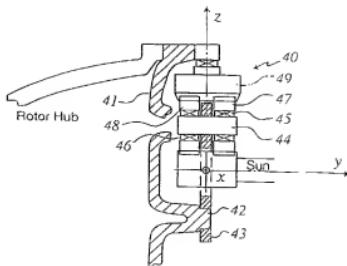


FIG. 4

The Office Action of August 18, 2010, contends that each of the primary references WO '644, WO '690 and WO '566 discloses all of the elements as claimed except for planet gear bearings that are taper roller bearings. The Office then relies

on WO '398 to teach a planetary gear transmission having sun, planet and ring gears and a carrier wherein circumferentially spaced shafts support and locate circumferentially spaced planet gear bearings in the form of taper roller bearings on which the planet gears are mounted. The Office concludes that it would have been obvious to one of ordinary skill in the art to replace the bearings of any of the primary references with taper roller bearings, in view of WO '398, in order to better distribute the contact pressure of the rollers. Applicants respectfully disagree with this conclusion. Contrary to the position taken in the Office Action, one would not make such a simple substitution.

One of skill would recognize that although taper roller bearings are known and may provide advantages in certain cases (see, e.g., [0023] to [0029] of WO '398) such advantages apply only to cylindrical bearings for a gear unit that does not include a bogie plate. The combined references fail to teach or suggest a gear unit having the combination and arrangement of features, including taper roller bearings, as recited in the present claims.

(vii-b) First ground of rejection

WO '398 describes a planetary gear transmission that is totally different than that disclosed in WO '644. One major distinction between the references is the bogie plate component. The mechanical design shown in Fig. 2 of WO '644 teaches a bogie

plate (21) which supports at both sides planet shafts (19) on which planet gears are bearing mounted (25). One of ordinary skill would recognize this is a rather complicated configuration.

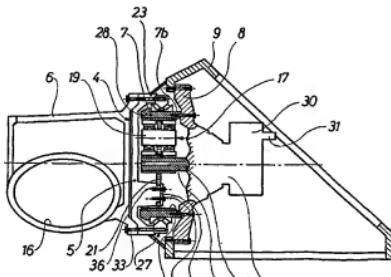


Fig. 2

In contrast, in WO '398, the construction is very straight forward. As seen in Fig. 3 below, the planet shafts (31) are firmly supported at both sides in the walls of a planet carrier (30), which is a so-called "cage type" planet carrier, and only single planet gears are used instead of pairs of planet gears at opposite sides of a bogie plate.

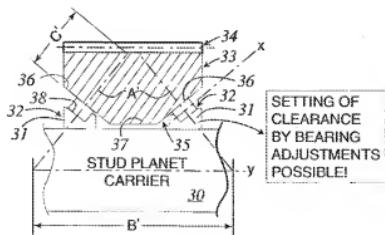


FIG. 3

One of ordinary skill in the art would recognize that the type of "complicated" design shown in WO '644 is required when used with a bogie plate. In the design of WO '398, however, a completely different choice would be made. In a cage type planet carrier, the designers have chosen a rigid, non-resilient option in distinction from a more elastic, resilient design utilized in WO '644.

In a rigid design, the aim is to withstand the force load on the structure, while minimizing the deformation of the structure, which typically results in the use of non-resilient materials or mechanisms, having a high modulus of elasticity and in dimensions being oversized for withstanding the load, the designs being usually heavier.

On the contrary, in an elastic design, the structure under load is accepted as being inevitable and therefore resilient materials or mechanisms are typically used which are able to cope with the deformation of the structure, and the dimensions of the structure are typically much smaller and of a lighter weight.

One of ordinary skill in the art would have this knowledge about mechanical design and would understand that WO '644 corresponds to a resilient/elastic design, whereas WO '398 is a rigid design. Indeed, the planet shifts in the rigid design of WO '398 are fixed at both extremities in the walls of a planet carrier so that deformation of such a shaft is very limited. In

the elastic designs of WO '644, the planet gears and shafts are given more freedom for being deformed by supporting the planet shifts at only one of their extremities on the planet carrier.

When deformation of the structure is allowed as in the elastic design of WO '644, the design becomes much more complicated because the intermeshing between the sun, planet and ring gears introduces high stress levels in the gear teeth which can then damage the gear. In order to solve this problem, a further step in the elastic design is to double the planet shafts and planet gears, the planet shafts being supported in their middle on a bogie plate. Interaction between the moving planet carrier and the fixed ring wheel results in a deformation and load which is symmetrical with respect to the bogie plate. In this way, forces and deformation at both sides of the bogie plate are balanced, which is compatible with the gear meshing.

Thus, the designers of WO '644 did not make things unnecessarily complicated, but utilized an elastic design. This provides a lighter structure and a reduced risk of sudden breakdown.

For example, as detailed in WO '644, "The planetary wheels of the planetary holder co-operate through their teeth with the inner gear portion of the ring gear, said planetary holder being rotatably arranged inside the tubular member by means of a radial-axial-roller bearing and a ball bearing arranged on their respective sides of the ring gear. As the

planetary wheels are of a simple and wide structure, and as the bearings are rather rigid, a considerable risk applies of the rotor breaking down in case the forces on the planetary holder are instantaneously very heavy. Such a structure is not completely satisfactory with respect to wind turbines generating a very strong power." (See, WO '644 Background Art, emphasis added).

In order to overcome the disadvantages of this type of planetary gear transmissions, WO '644 teaches: "The object of the invention is to provide a wind turbine of the above type which is suited for wind turbines generating a very strong power and which is very compact while ensuring that the bearing of the planetary holder possesses a predetermined resilience." (See, WO '644 page 2, emphasis added). The solution offered by WO '644 is planet wheels at opposite sides of a bogie plate, wherein "As a result, a very compact structure is obtained, and the planetary holder can yield slightly at each planetary wheel ..." (See, WO '644 page 2).

WO '644 also teaches: "According to the invention, each planetary wheel of each set of planetary twin wheels may be mounted on the bogie shaft by means of a double spherical roller bearing, preferably a radial-axial roller bearing, the rollers of which can run in a common track in an outer race of the bearing. As a result, particularly good possibilities are obtained of both planetary wheels of each set of planetary wheels being able to

carry out very weak lateral inclinations in such a manner that it is ensured that the stresses transferred through the teeth of the planetary wheels are always uniformly distributed across the entire tooth width." (See, WO '644 page 2, emphasis added).

So, WO '644 teaches the use of spherical roller bearings in order to avoid high stresses in the gear teeth when the elastic structure is deforming.

When one of ordinary skill in the art of designing gear transmissions decides to continue with a complicated configuration in which planet shafts and planet gears are provided at opposite sides of a bogie plate, instead of using a simple configuration with a rigid cage type planet carrier as in WO '398, the reason must be that one knows about the mechanics behind the structure, i.e., that the structure is elastic and resilient, and is more compact. Thus, in contrast to the position taken in the Office Action, it is far from obvious that one would simply decide to "substitute" the taper roller bearings of WO '398 in the configuration of WO '644.

One of ordinary skill in the art, with the need to obtain a compact structure which has less risk of breaking down, would understand that a resilient design is to be used having a bogie plate and pairs of planet shafts and planet gears. One would not further include a rigid bearing with a lower degree of freedom, such as a taper roller bearing.

The Office Action contends that it would have been obvious to replace the bearings of WO '644 into taper roller bearings to "better distribute contact pressure of the rollers due to inclined direction of loading which increases the amount of material available for distributing the load in the interaction with the loads coming from the gears." While the advantages set forth by the Office may make sense in regard to WO '398, these advantages do not make sense in the configuration of WO '644.

In WO '398, it is reasoned that a taper roller bearing provides a better distribution of the contact pressure due to inclined direction of the loading "which increases the amount of material available" (see, page 4, lines 9-14). But, this is compared with the configuration of Figure 2a in WO '398 in which cylindrical bearings are used and in which the loading is not inclined at all.

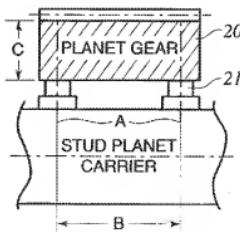


FIG. 2a

One of ordinary skill would have understood that a double spherical roller bearing has rollers which make contact with the bearing rings in an inclined direction, so that the same amount of material for distribution of the load is available as with taper roller bearings.

So, again, one of ordinary skill would not replace in the elastic design with bogie plate of WO '644, having double spherical bearings that provide a good load distribution and allow deformation of the planet shafts and reduce stresses on the gear teething, with a taper roller bearing which does not provide a better load distribution compared to the spherical roller bearing, is known to be more rigid, and provides a lower degree of freedom.

The Office Action of August 18, 2010, points to paragraphs [0025] to [0029] of WO '398 for additional reasons for substituting using taper roller bearings. Again, the alleged advantages of a taper roller bearing do not apply to the design of WO '644.

For example, paragraph [0026] of states "increased working distance (B and B' in Figures 2a and 3) because of inclined working lines A' in O-arrangement of the two tapered bearings results in better stability, for instance versus moments created by the presence of axial forces inherent in the use of helical gears". As is clear from Figure 3 of WO '398, with taper roller bearings mounted in an O configuration, the directions in

which load is transferred between the inner bearing ring and the outer bearing ring are represented by lines A'.

In the case of a cage type planet carrier, wherein the planet shafts are supported at their both ends in the planet walls, then such an O-configuration can provide better support, and better stability for coping with moment loads. The load transfer is towards the place where the shaft is fixed in the planet carrier and less deformation of the planet shaft is to be expected. Such an assembly of taper roller bearings in an O-configuration does not result in a better stability, however, when applied for supporting the planet gears in the transmission of WO '644. These planet gears are supported on planet shafts which are fixed at only one of its extremities to a bogie plate. Therefore, the application of such a configuration will rather result in less stability, certainly when it comes to certain moment loads.

Paragraph [0027] of WO '398 discloses that "maximum mass (bulk) and stability of the rim section is achieved with no or minimal local stress relieving notches, as exemplified in comparison of Figures 2a, b and Figure 3." Again, spherical roller bearings provide the same maximum mass and stability of the rim section as taper roller bearings due to the inclined position of the rollers. Thus, the references fail to provide any reason to make the substitution for a taper roller bearing.

Paragraphs [0028] and [0029] of WO '398 describe the adjustment of clearance and preload in an arrangement with taper roller bearings. "The clearance of the bearing arrangement can be set (Figure 3) for optimal guiding of the gear contact and load distribution in the bearings. Setting of minimal clearance or even preload, together with increased stiffness leads to a high level of precision in positioning of the output shaft both under no load and under load conditions, which can be very important in wind turbine applications."

As detailed above, taper roller bearings are different from spherical roller bearings and other types of bearings in that they are generally of separable design, i.e., the inner ring with roller and possible cage assembly forms a unit which can be mounted separately from the outer ring. That's the reason why the clearance or pre-load can be set during mounting, which is on the other hand not a simple process. It is clear that this advantage of taper roller bearings, i.e., that minimal clearance and preload can be obtained resulting in an increased stiffness and a high level of precision in positioning (less freedom), is again only an advantage for the rigid design of WO '398 but not for the according to WO '644.

For all of these reasons, the combined teachings of WO '644 and WO '398 fails to teach or suggest, and would not have rendered obvious, a planetary gear transmission unit having the

combination and arrangement of features set forth in claims 1-12,
15 and 16.

Claim 5

Claim 5 depends from claim 1 and further defines that each planet gear of a pair is mounted on a pair of tapered roller bearings. The Office Action contends that the spherical roller bearings (25) shown in WO '644 (Figure 3) form a pair of bearings for gear 17a and gear 17b respectively, and that taper roller bearings can be used as the pair of roller bearings.

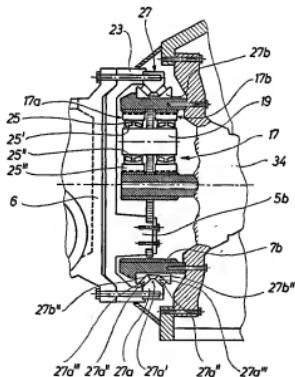


Fig. 3

One of ordinary skill in the art would recognize that a spherical bearing has two rows of rollers, but that it is still just one bearing and not a pair of bearings. Included herewith in the Evidence Appendix is a catalogue page from SKF company, and a printed internet web site page from Timken company, two well known

and established bearing manufacturers. The documents show that a spherical roller bearing has two rolls of rollers.

With respect to the clearance setting in taper roller bearing assemblies, it is clear that the way of mounting and the provisions required for supporting the bearing rings of taper roller bearings are completely of another kind than spherical roller bearings. Contrary to the position taken in the Office Action, it would not have been obvious to substitute the two.

For this additional reason, the combined teachings of WO '644 and WO '398 fails to teach or suggest, and would not have rendered obvious, a planetary gear transmission unit having the combination and arrangement of features set forth in claim 5.

Claim 6

Claim 6 depends from claim 1 and further defines that the tapered roller bearings are arranged in an O configuration. The Office Action contends that paragraph [0026] of WO '398 teaches that such a configuration augments stability.

As detailed in the above remarks, in an elastic design such stability is not necessary and may not in fact be desired. Because the planet shafts are only supported at one side on a bogie plate, it would not have been obvious that such a situation of an O-configuration in WO '644 would be more stable.

For this additional reason, the combined teachings of WO '644 and WO '398 fails to teach or suggest, and would not have

rendered obvious, a planetary gear transmission unit having the combination and arrangement of features set forth in claim 6.

Rule 132 Declaration

The Amendment filed November 19, 2009, included a Declaration under 37 CFR § 1.132 executed by inventor Warren Smook. The Office Action fails to properly consider the supporting evidence contained within the declaration. The Office holds the position that the evidence was not factually supported.

The declaration explains the concept of "degree of freedom". The declaration explains that a bearing with a higher degree of freedom accommodates deformations in an elastic design, whereas a bearing with a low degree of freedom does not accept certain deformations and is therefore more suitable for a rigid design. The declaration explains that at the time of filing the present application it was believed that the use of taper roller bearings in a configuration with a bogie plate was not workable. It was thought that all the degrees of freedom of a spherical roller bearing were necessary for accommodating the deformations in the flexible design. This is in line with the knowledge disclosed in the cited prior art references.

While spherical roller bearings allow rotation around three different directions, a taper roller bearing is only compliant with a rotation around a main axis. As explained in the Smook declaration, applicant surprisingly found that taper roller

bearings having such a low degree of freedom could be used in a configuration with a bogie plate.

Indeed, it was discovered that the necessary additional flexibility for accommodating deformations in the structure in a flexible design with a bogie plate can be provided by a sufficient self-alignment of the supporting planet shafts, for example, due to a sufficiently flexible bogie plate, and planet shafts executed as a flexpin shaft.

Therefore, WO '644 and WO '398 fail to render the present invention *prima facie* unpatentable, and this rejection should be withdrawn.

(vii-c) Second ground of rejection

The second ground of rejection utilizes WO '690 as the primary reference in combination with WO '398. Again, the Office Action holds the same position that WO '690 discloses all of the elements as claimed except for planet gear bearings that are taper roller bearings. The Office applies WO '398 to teach the substitution of taper roller bearings and concludes that it would have been obvious to one of ordinary skill in the art to replace the bearings of WO '690 with taper roller bearings.

For all of the same reasons as detailed above, Applicants respectfully disagree with this conclusion. One of ordinary skill would not have substituted taper roller bearings in the configuration disclosed in WO '690. Thus, the combined

teachings of WO '690 and WO '398 fails to teach or suggest, and would not have rendered obvious, a planetary gear transmission unit having the combination and arrangement of features set forth in claims 1-13, 15 and 16.

Therefore, WO '690 and WO '398 fail to render the present invention *prima facie* unpatentable, and this rejection should be withdrawn.

(vii-d) Third ground of rejection

The third ground of rejection utilizes WO '566 as the primary reference in combination with WO '398. Again, the Office Action holds the same position that WO '566 discloses all of the elements as claimed except for planet gear bearings that are taper roller bearings. The Office applies WO '398 to teach the substitution of taper roller bearings and concludes that it would have been obvious to one of ordinary skill in the art to replace the bearings of WO '566 with taper roller bearings.

For all of the same reasons as detailed above, Applicants respectfully disagree with this conclusion. One of ordinary skill would not have substituted taper roller bearings in the configuration disclosed in WO '566. Thus, the combined teachings of WO '566 and WO '398 fails to teach or suggest, and would not have rendered obvious, a planetary gear transmission unit having the combination and arrangement of features set forth in claims 1-13, 15 and 16.

Therefore, WO '566 and WO '398 fail to render the present invention *prima facie* unpatentable, and this rejection should be withdrawn.

(vii-e) Fourth ground of rejection

The forth ground of rejection applies all four of the cited references to claim 13. Claim 13 depends from claim 1 and further defines that the planet gears are supported relative to the bogie plate by a flexpin shaft.

For at least the reason that the cited references, WO '644, WO '398, WO '690 and WO '566, alone or in any combination, fail to teach or suggest the planetary gear transmission unit as featured in claim 1, then these references cannot render dependent claim 13 obvious.

Therefore, WO '644, WO '398, WO '690 and WO '566 fail to render the present invention *prima facie* unpatentable, and this rejection should be withdrawn.

Conclusion

In view of the above remarks, WO '644, WO '690, WO '566 and WO '398, alone or in any combination, fail to teach or suggest, and fail to render obvious, the planetary gear transmission unit having the combination and arrangement of features as recited in the present claims. Accordingly,

Applicants request reconsideration and reversal of the rejections.

The Appeal Brief fee of \$540 is being paid concurrently herewith online by credit card.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future submissions, to charge any underpayment or credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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Enclosures: Claims Appendix
Evidence Appendix

(viii) **Claims Appendix**

1. A planetary gear transmission unit comprises sun, planet and ring gears and a planet carrier, said planet carrier having circumferentially spaced studs which support a planet bogie plate, the planet bogie plate providing support for circumferentially spaced shafts, which support and locate circumferentially spaced planet gear bearings on which planet gears are mounted, and at least some of said planet gear bearings being taper roller bearings.

2. A gear transmission unit according to claim 1, wherein said planet gears are arranged in axially aligned pairs.

3. A gear transmission unit according to claim 2, wherein the bearings support respective pairs of aligned planet gears.

4. A gear transmission unit according to claim 3, wherein two gears of each pair are positioned at opposite sides of the plate.

5. A gear transmission unit according to claim 1, wherein each planet gear of a pair is mounted on a pair of tapered roller bearings.

6. A gear transmission unit according to claim 1 and comprising a pair of tapered roller bearings arranged in an O configuration.

7. A gear transmission unit according to claim 1, wherein the bearings for each circumferentially spaced planet gear position are supported on a shaft which, in use, self adjusts in said angular position relative to the bogie plate.

8. A gear transmission unit according to claim 1, wherein the bearings for at least some circumferentially spaced planet gear positions are supported on a shaft which is substantially, rigidly secured to the bogie plate.

9. A gear transmission unit according to claim 8, wherein each said shaft is substantially rigidly secured to the bogie plate.

10. A gear transmission unit according to claim 7, wherein the bogie plate is able to deform elastically to allow self adjustment of the angular position of the or each shaft relative to the axis of rotation of the ring gear.

11. A gear transmission unit according to claim 1,

wherein a main bearing comprises an inner ring bearing surface of a diameter greater than that of the toothed surface of the ring gear.

12. A gear transmission unit according to claim 1 wherein the planet carrier provides a radially extending torque transmissions path which is torsionally stiff but relatively compliant in an axial direction parallel with the axis about which the rotational forces act.

13. A gear transmission unit according to claim 1, wherein the planet gears are supported relative to the bogie plate by a flexpin shaft.

14. (canceled)

15. A gear transmission unit according to claim 8, wherein the bogie plate is able to deform elastically to allow self adjustment of the angular position of the or each shaft relative to the axis of rotation of the ring gear.

16. A gear transmission unit according to claim 9, wherein the bogie plate is able to deform elastically to allow self adjustment of the angular position of the or each shaft relative to the axis of rotation of the ring gear.

(ix) Evidence Appendix

- catalogue page from SKF company
- printed web site page from Timken company
- Rule 132 Declaration of Warren Smook

(x) Related Proceedings Appendix

None.